

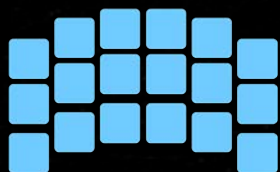
# The Roman Science Support Center at IPAC

L. Armus (SSC)

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*15 November 2021*

NANCY GRACE  
**R.OMAN**



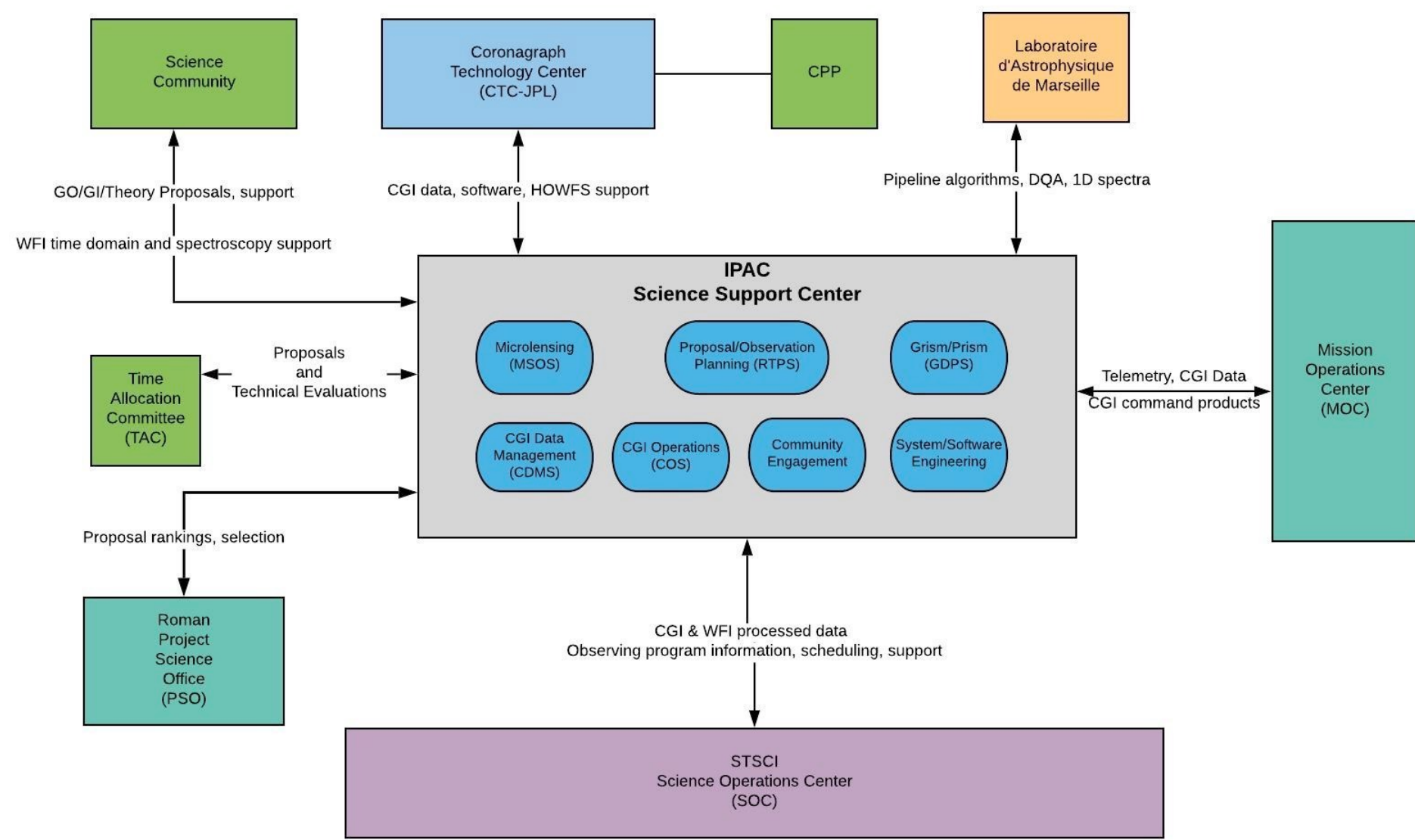
SPACE TELESCOPE

- The SSC at IPAC works with the other Ground System elements to achieve the scientific and operational goals of the Roman mission.
- Primary SSC Responsibilities include:
  - **Science Data pipelines**
    - *Science data processing for the Galactic Bulge Time Domain Survey*
    - *Science data processing for all Wide Field Spectroscopy mode data including the High Latitude Wide Area, Time Domain and General Astrophysics surveys*
  - **Coronagraph Instrument Operations**
    - *CGI Observation scripts and procedures*
    - *Data Analysis Environment for CGI data processing*
    - *High Order Wave Front Sensing and Control (deformable mirror) operations*
    - *CGI health, safety and performance monitoring*
  - **Proposal calls, peer reviews and community grants**
    - *Issue Roman Observing/Data Analysis/Theory proposal calls*
    - *Manage the peer review and time allocation process and investigator grants*
  - **Community engagement**

- The SSC works with the Roman Project Science Office and the Science teams to:
  - *Understand science requirements of the mission*
  - *Define operational and data processing scenarios*
  - *Discuss potential roles and contributions of future Science Teams*
- IPAC and SSC scientists are directly involved in current Roman Galactic Bulge Time Domain, High Latitude Wide Area and High Latitude Time Domain Survey Science Investigation Teams.
- The SSC participates in Roman working groups focusing on WFI calibration, wide field spectroscopy data processing, data formats, simulations, etc.
- The SSC participated in the Formulation Science Working Group (FSWG) and continues to participate in The Roman Science Interest Group (RSIG).
- The SSC team includes scientists with expertise in:
  - *Microlensing data reduction and analysis*
  - *Direct exoplanet imaging and coronagraphy*
  - *Wide field Infrared spectroscopic data reduction, analysis and simulations*
  - *Cosmology, supernovae, MW and galaxy evolution*



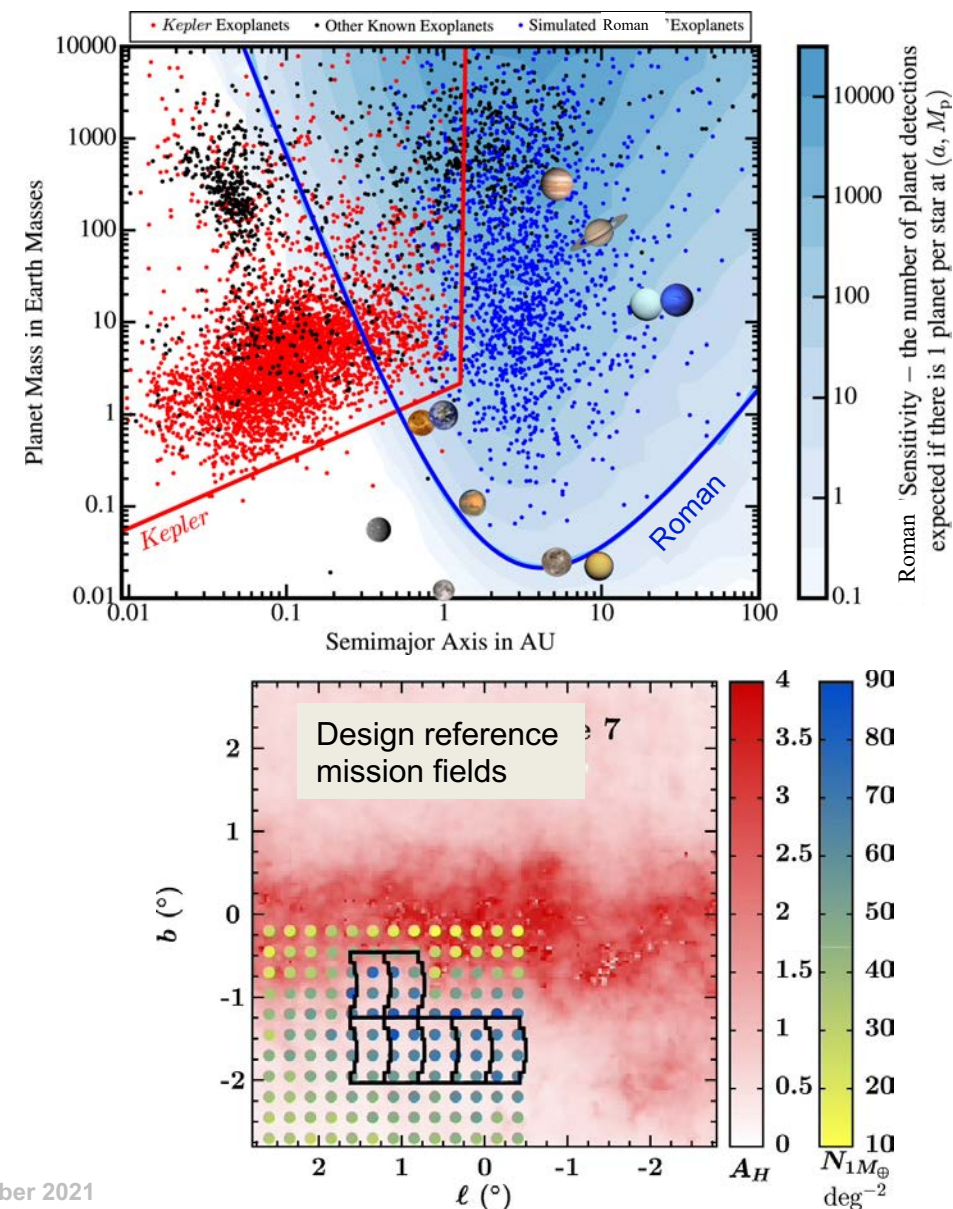
# Key SSC Interfaces



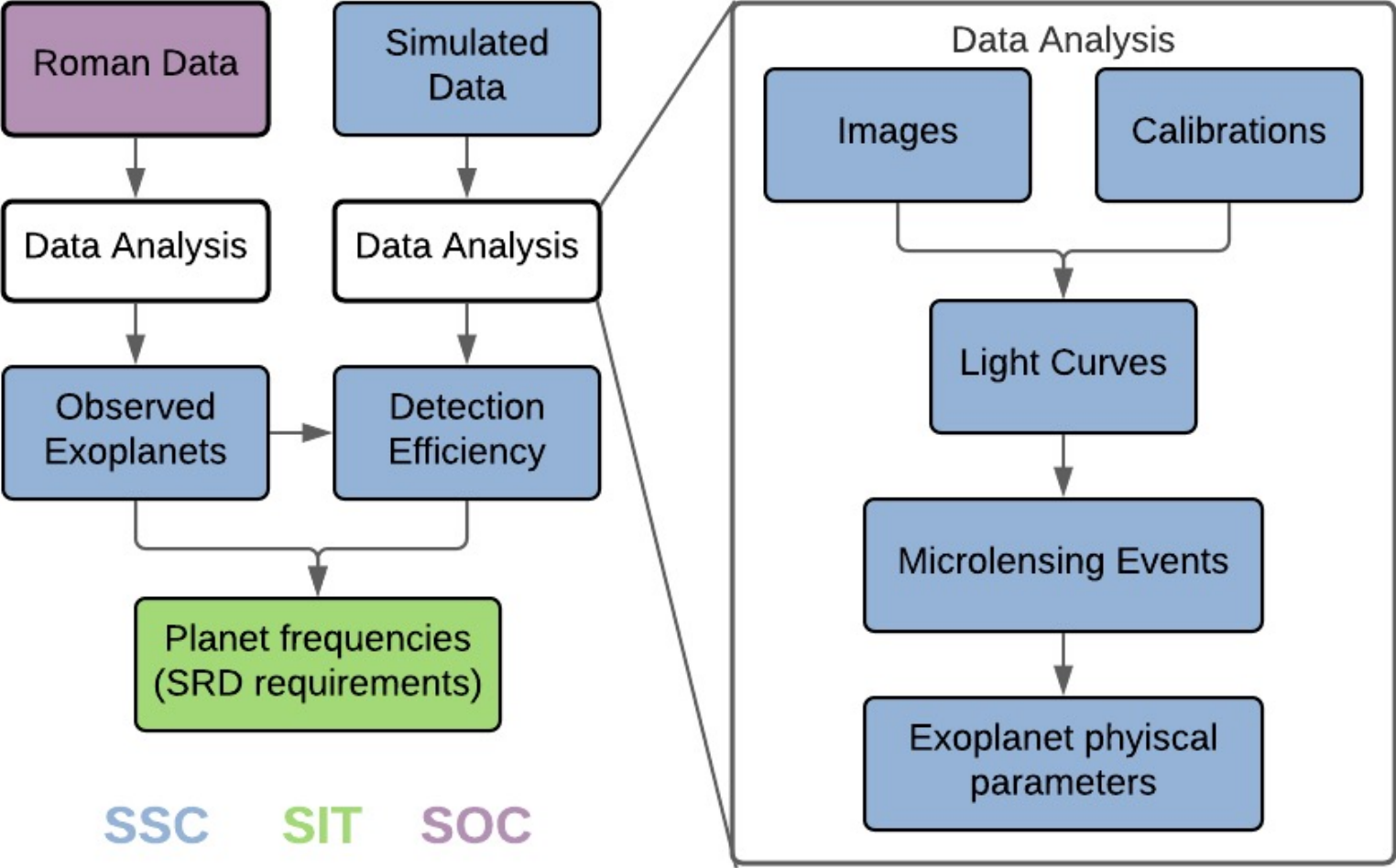
- **Microlensing Science Operations System** (MSOS): WFI microlensing data processing for the Roman Galactic Bulge Time Domain Survey, which will produce high-level science data products and deliver these to the Roman archive.
- **Grism and Prism Data Processing System** (GDPS): WFI wide-field spectroscopy data processing for the High Latitude Wide Area, High Latitude Time Domain and Guest Observer surveys, which will produce high-level science data products and deliver these to the Roman archive.
- **CGI Operations System** (COS): CGI operations support including validation of commanding products and instrument health, safety and performance trending, and support of the High Order Wavefront Sensing and Control (HOWFSC) Ground in the Loop (GITL) operations.
- **CGI Data Management System** (CDMS): CGI instrument support including low-level data processing, user support, providing a Data Analysis Environment (DAE) which will be used to produce high-level data products, validate and deliver these products to the Roman archive.
- **Roman Telescope Proposal System** (RTPS): Roman Telescope proposal ingest, time allocation committee review process, and grants management.
- **Community Engagement**: Interface with the scientific user community for Roman exoplanet science, proposal preparation and submission, and spectroscopic science.

The primary responsibilities of the **Microlensing Science Operations System** (MSOS) support the high-level exoplanet census science goals and are to:

- Implement and operate the MSOS pipeline, including light curve generation, starting from Level-2 images, identifying microlensing events, deriving stellar and planetary parameters, and measuring the pipeline detection efficiency.
- Produce Level-3 & 4 data products, including images, light curves, catalogs, detection efficiency, completeness and reliability and DQA products.
- Deliver Level-3 & 4 data products to the Roman archive.
- Support the community in analyzing Roman microlensing data.
- Release pipeline modules and associated documentation to the community.



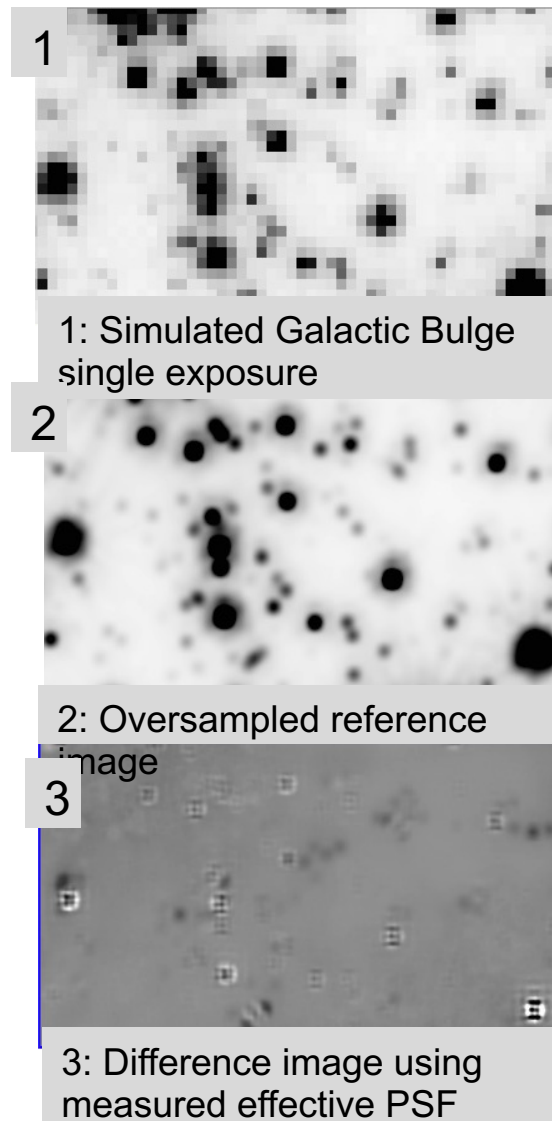
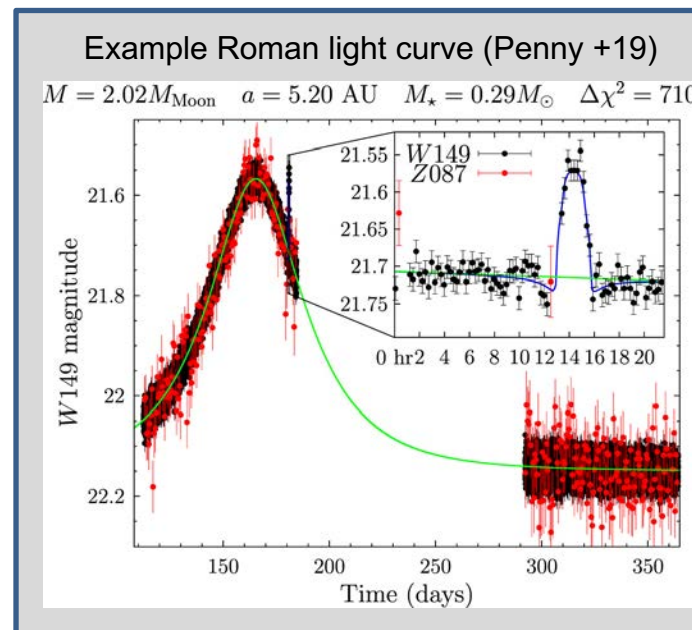
# MSOS Pipeline High-level Science Flow





## Data products available to the community via the Roman archive:

- Reference frame used to generate object catalog (~200 million stars)
  - Wide filter: every 8 days
  - Other filters: per season
- Object Catalog
  - ID, position, flux, FWHM: per 8 days
  - Proper motion, trigonometric parallax: per season/survey
  - Flags: variability, blending, QA
- Light Curves (**updated in archive within 5 days**)
  - Difference image analysis (DIA) photometry, per exposure
  - PSF photometry, per exposure
  - Optimized light curves for microlensing events, per season
- Variability Catalog
  - Variability metrics
- Microlensing Event Catalog
  - Model parameters and QA : single and binary lens or source with higher order effects
  - Physical parameters of the lens system
  - Constraint on the lens flux
- Detection efficiency
  - False negative and false positive rates
    - Using both pixel and image-level catalog injections
  - Microlensing detection efficiency
    - Single lens and binary lens event
- Reddening and extinction maps

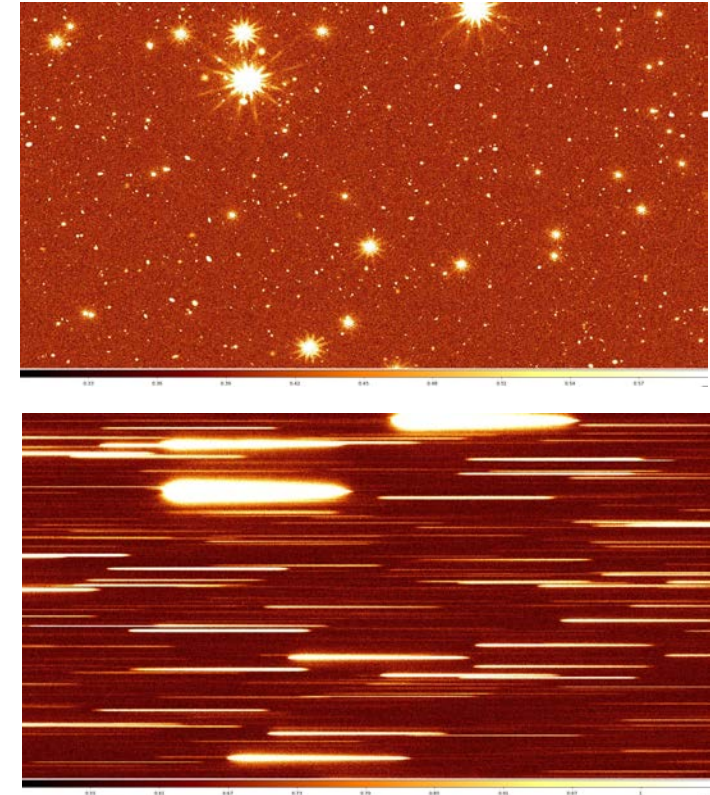




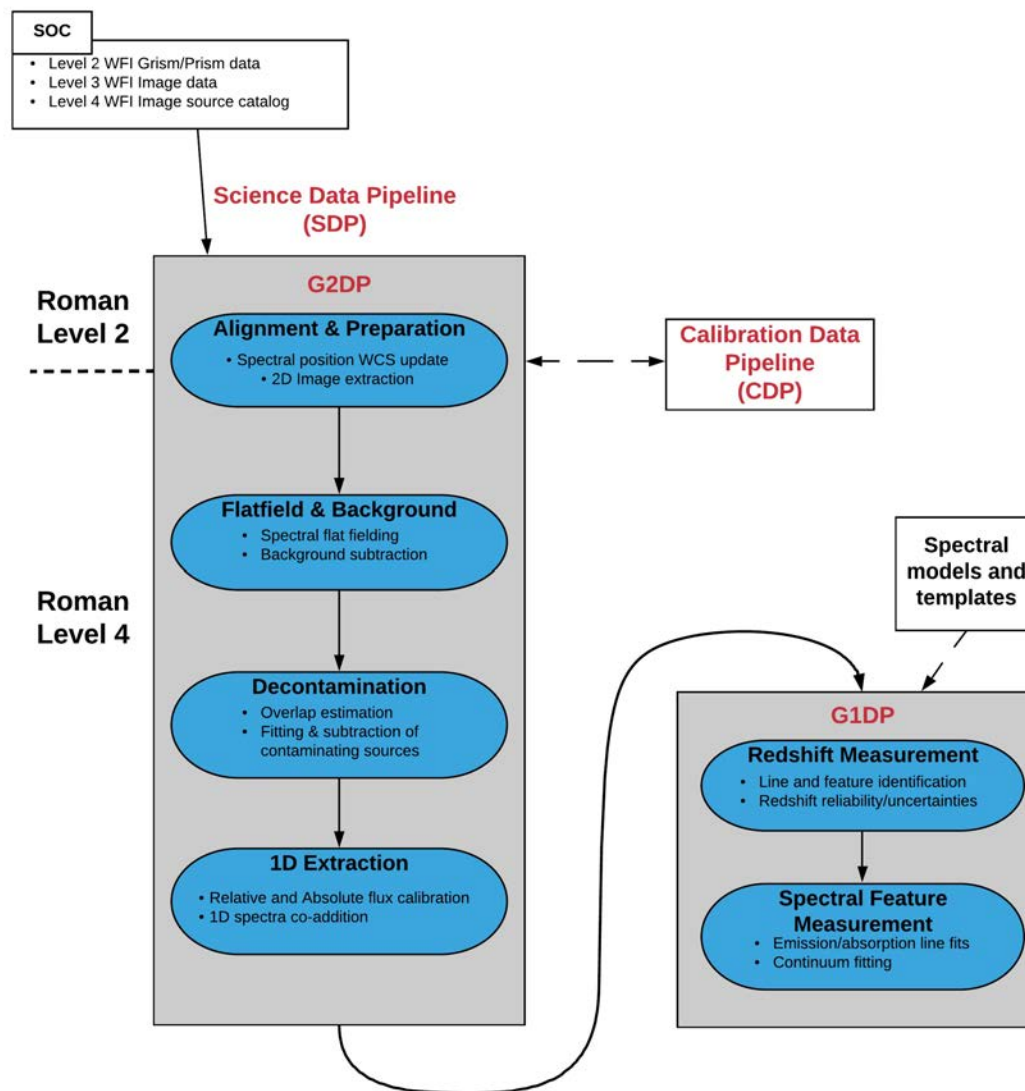
The SSC and the Laboratoire d'Astrophysique de Marseille (LAM) are collaborating to create the Roman **Grism-Prism Data Processing System** (GDPS). The primary responsibilities of the GDPS are to:

- Implement and operate the Roman Wide Field Spectroscopy Mode (WSM) pipelines that will operate on all WFI spectroscopy data (High Latitude Wide Area, Time Domain and General Astrophysics surveys).
- Produce Level-4 WSM grism and prism science and calibration data products, including decontaminated 2D and 1D spectra, catalogs, redshifts and spectral fitting results, and DQA products.
- Deliver Level-4 science data products to the Roman archive.
- Support the community in analyzing Roman WSM data.
- Release pipeline modules and associated documentation to the community.

The GDPS heavily leverages Euclid development and expertise at LAM and the Euclid NASA Science Center (ENSCI) at IPAC.

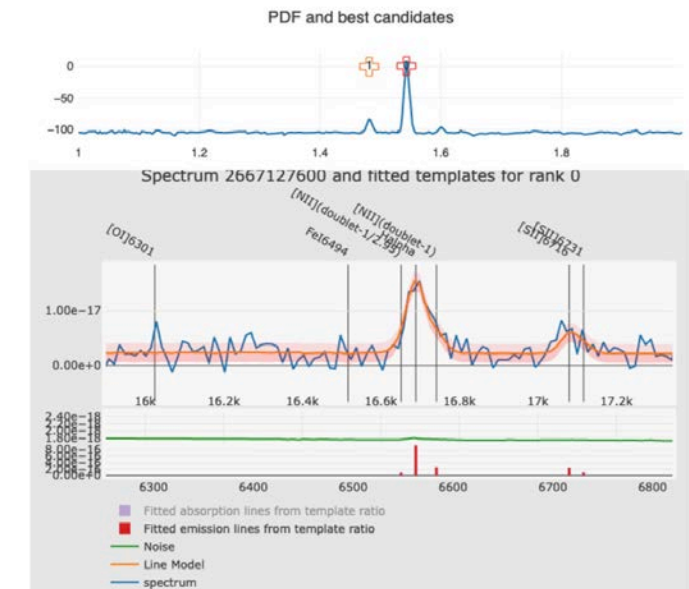
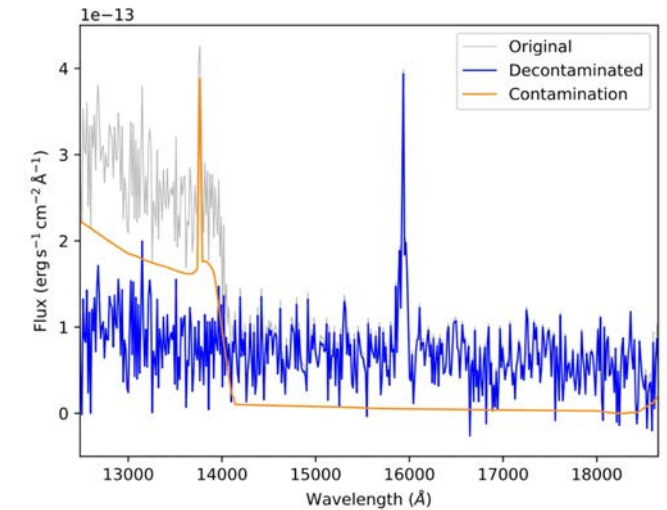


- Basic data flow for the Science Data Pipeline (SDP).
- WFI spectroscopic and image science and calibration data are inputs to the 2D (G2DP) and calibration (CDP) pipelines.
- G2DP outputs are inputs for the G1DP.



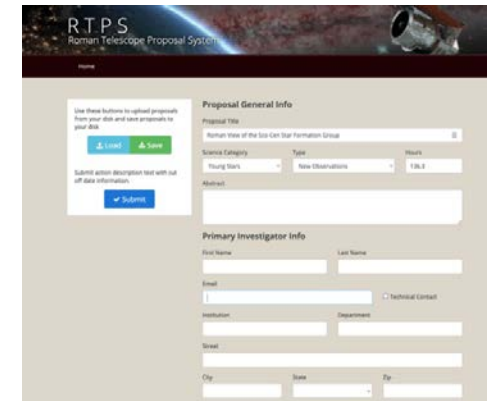
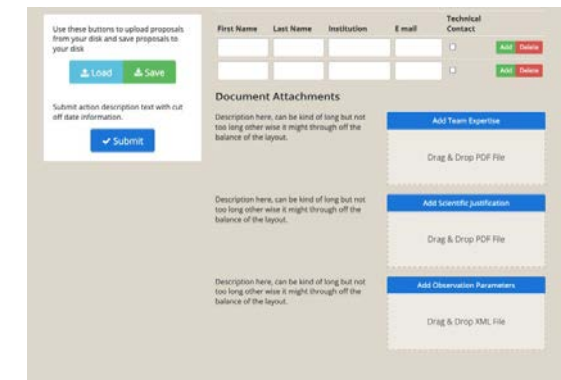
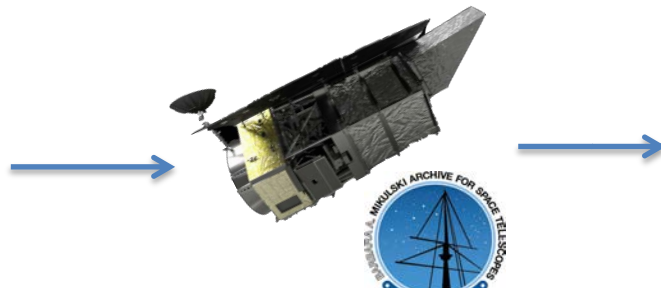
Data Products available to the community via the Roman archive:

- Updated spectra location tables and WCS astrometric information for grism and prism L2 data.
- Background subtracted 2D spectral images
- 2D decontaminated spectral cutouts
- Spectral overlap parameters for each extracted source
- 1D fully calibrated spectra (including uncertainties) for each extracted source
- Redshifts and z-PDF's, emission/absorption line and continuum parameters for all 1D spectra
- Calibration Reference Files (flats, wavelength solutions, zero points, etc.) used to generate the 2D and 1D spectra
- Data Quality Assessment reports and data flags
- Grism and prism spectra are processed in the same pipeline. Difference imaging and time series fitting (and differencing) of spectra (e.g., to detect and measure SNe in the host galaxy) will be done by science teams



The primary responsibilities of the **Roman Telescope Proposal System (RTPS)** are:

- Issue the calls for General Astrophysics surveys, Data analysis and Theory proposals. Current plan is for 5 proposal calls. First call issued at ~L-12.
- Together with SOC, support the community in proposal preparation/submission.
- Design proposal submission software. Single, web-based system maintained by SSC with links to templates, tools (e.g. APT), etc.
- Maintain a database of proposals and proposers
- Manage the proposal peer review (dual anonymous) process
- Notify proposers of results and support post-selection process
- Manage Roman proposal grants
- Support the community via regular workshops, on-line documentation, and a helpdesk



- The SSC supports the scientific user community particularly for Roman exoplanet science, WFI spectroscopy, CGI operations and observations, and proposal preparation and submission
- Develop and maintain a Roman website (WFI and CGI simulations, meeting information, parameter updates, links to partner websites and other Roman resources, etc.) and a helpdesk system
- Support and organize Roman science conferences and workshops for the astronomical community
  - AAS 239 splinter, Weds. Jan 12, 10am MST “*Testing Hierarchical Models of Galaxy Evolution with the Roman Space Telescope*” session # 2264
- Support the general public and provide educational and public outreach products in these areas, in coordination with the Roman Communications Board.

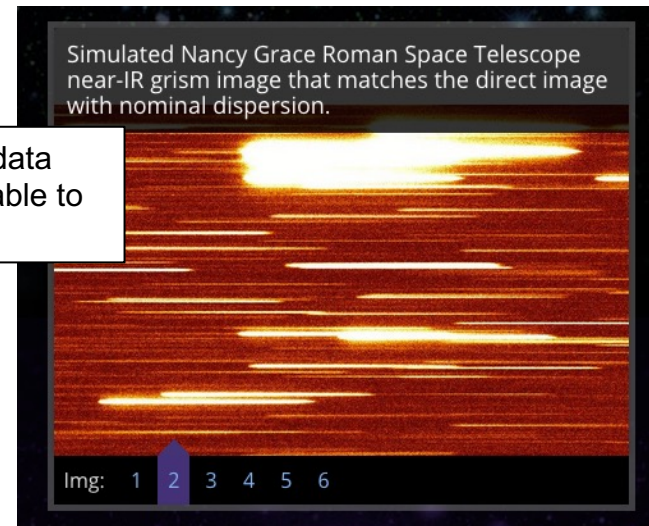


Previous meetings on GO science, microlensing, exoplanets, etc.

SSC website: <https://roman.ipac.caltech.edu>

SSC Helpdesk: [roman-help@ipac.caltech.edu](mailto:roman-help@ipac.caltech.edu)

Example WSM data simulation available to community





## Exploring the Transient Universe with the Nancy Grace Roman Space Telescope

February 8 - 10, 2022 • On the Caltech campus and online

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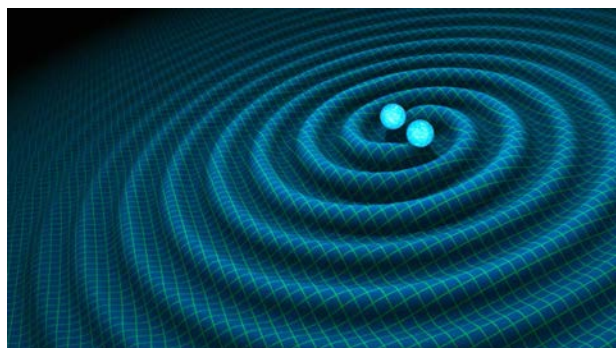
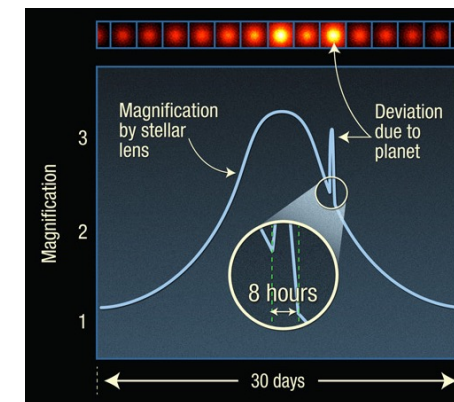
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Time-domain astrophysics comprises a vast array of phenomena, that span the range from our own Solar System to high-redshift galaxies, from asteroids and comets to novae, supernovae, active galactic nuclei, and gamma-ray bursts. We are now at the dawn of multi-messenger astrophysics, with the electromagnetic signatures of gravitational-wave sources within our observational grasp, most recently illustrated by the binary neutron-star merger GW170817. The Nancy Grace Roman Space Telescope will be a powerful observatory for exploring the time-varying Universe. Via its core surveys, it will search for supernova explosions at cosmological distances, as well as for the microlensing signatures of planets orbiting stars in our Galaxy. Roman will naturally enable serendipitous discoveries and analyses of many other time-variable phenomena during the course of its mission, through a vigorous investigation program including new surveys. This 3-day conference will bring together inclusively members of the community to discuss the exciting time-domain astrophysics that will be investigated with the Roman Space Telescope.

Themes will include:

- Multi-messenger astrophysics
- Tidal disruption events
- Supernovae
- Cepheids, Miras, and other periodic variables
- Novae and related phenomena
- Massive-star eruptions and outbursts
- Gamma-ray bursts
- Fast radio burst counterparts and hosts
- Active Galactic Nuclei
- Microlensing
- Solar System objects
- Time-domain data mining software and tools
- Alerts and brokers
- Discovery space for new phenomena
- Synergies with other missions and facilities (Rubin, ELTs, Euclid, JWST, etc.)

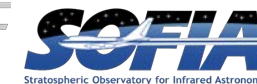


<https://conference.ipac.caltech.edu/romantimedomain/>

Abstract deadline = Nov. 29



- IPAC advances the exploration of our Universe through science operations, data archiving, and community support with a special focus on:
  - *Cosmology*
  - *Galaxy evolution*
  - *Exoplanets*
  - *Asteroids and the Solar System*
  - *IR/Sub-mm Astrophysics*
- IPAC has a long-standing, strong connection to the astronomical community through joint development and research on groundbreaking missions.
- We look forward to building on this legacy and working together on Roman.





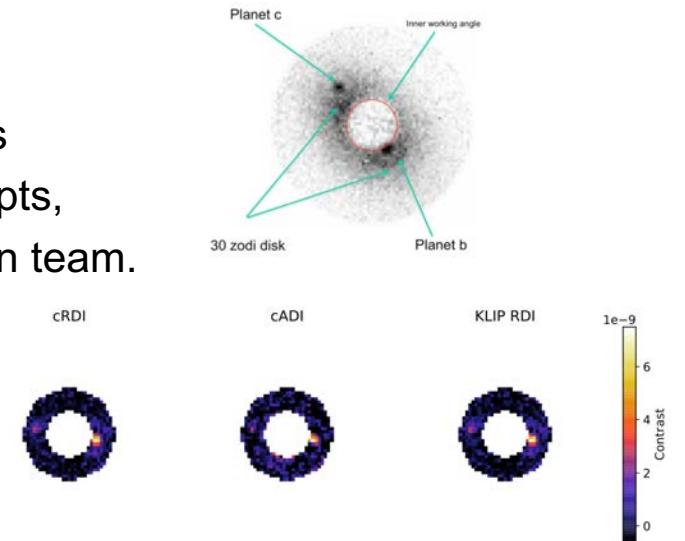
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SSC Helpdesk: [roman-help@ipac.caltech.edu](mailto:roman-help@ipac.caltech.edu)



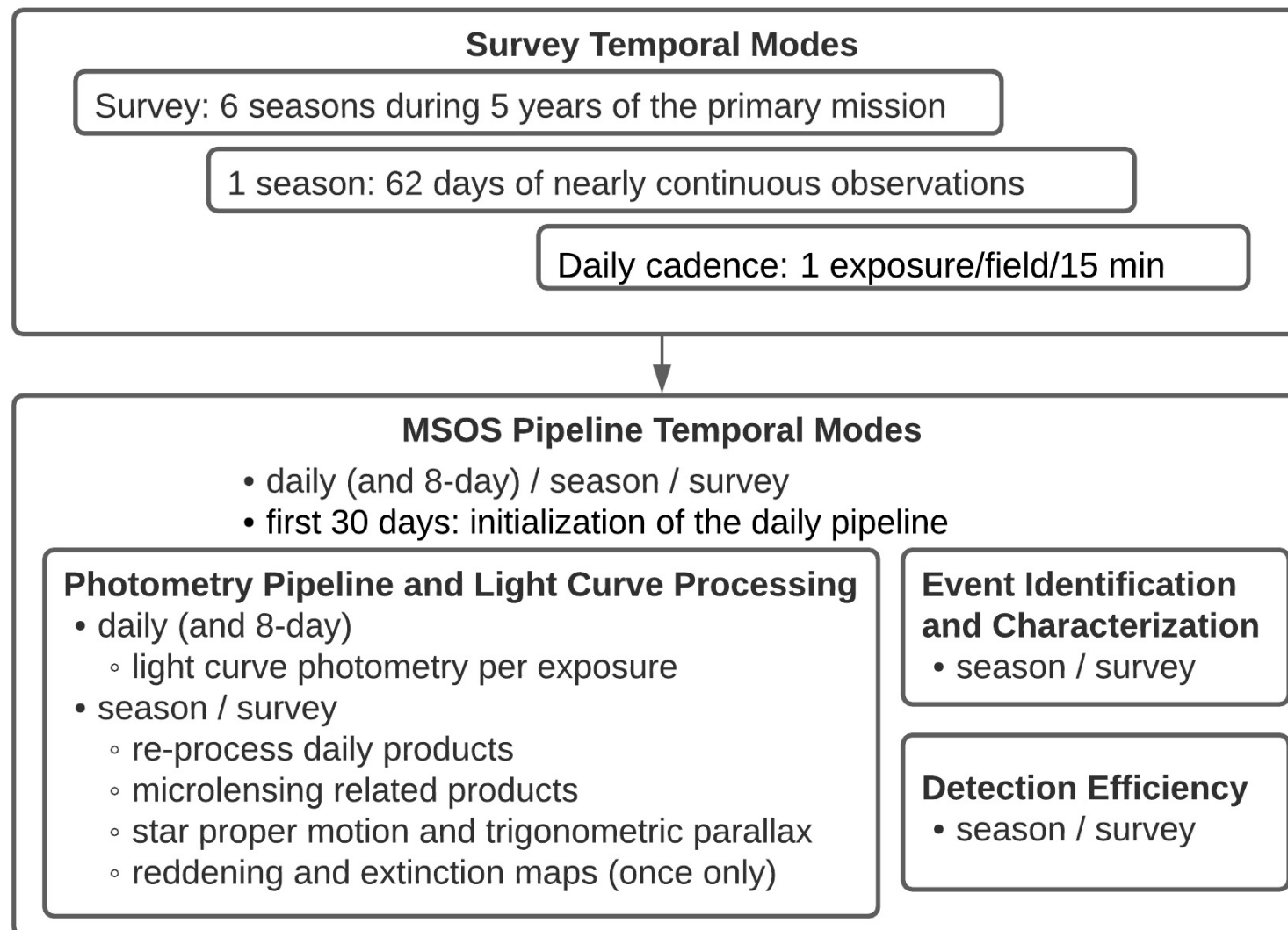
The SSC will manage the **CGI Operations System** (COS) and the **CGI Data Management System** (CDMS). The primary responsibilities of the COS and CDMS are to:

- **COS**
  - Command and operate the CGI during commissioning and nominal operations
  - Develop tools to create, format and validate CGI programs and observing scripts, based on designs and goals of the Coronagraph technology demonstration team.
  - Perform High Order Wavefront Sensing and Control/Ground In The Loop (HOWFSC/GITL) operations, processing and uplink
- **CDMS**
  - Produce Level-1 CGI data and deliver to the archive
  - Develop and operate a Data Analysis Environment (DAE) for the process of CGI data
  - Validate and deliver Level-2-4 CGI data produced by Coronagraph technology team to the Roman archive
- Assess and trend CGI Health & Safety, performance
- Support CGI I&T and Observatory I&T



CGI Information Session website: [https://roman.ipac.caltech.edu/mtgs/Roman\\_CGI\\_workshop.html](https://roman.ipac.caltech.edu/mtgs/Roman_CGI_workshop.html)

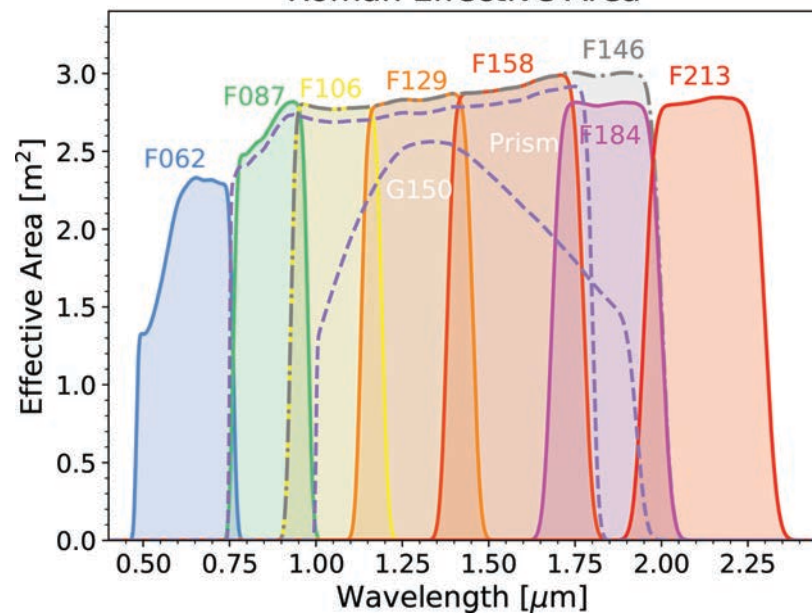
# MSOS Pipeline Temporal Modes



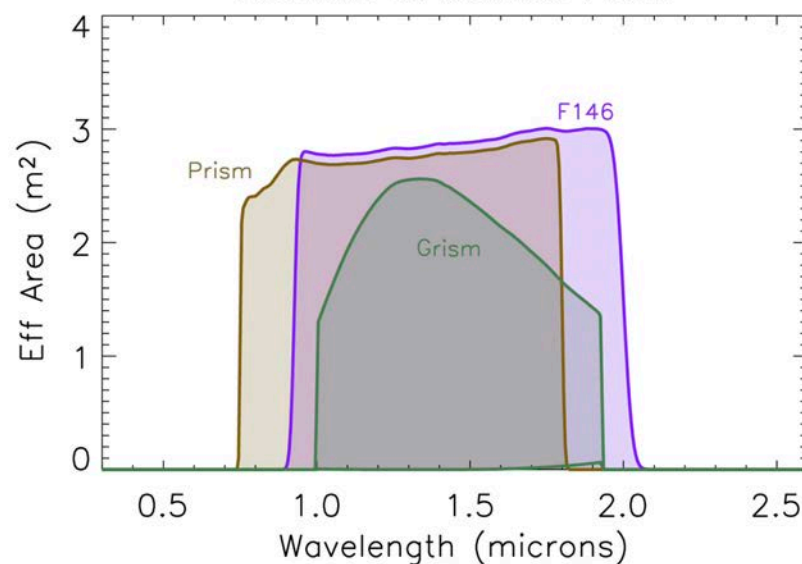
# Roman Dispersers

Element name	Min ( $\mu\text{m}$ )	Max ( $\mu\text{m}$ )	Center ( $\mu\text{m}$ )	Width ( $\mu\text{m}$ )	R
G150	1.0	1.93	1.465	0.930	$461\lambda(2\text{pix})$
P127	0.75	1.80	1.275	1.05	80-180 (2pix)

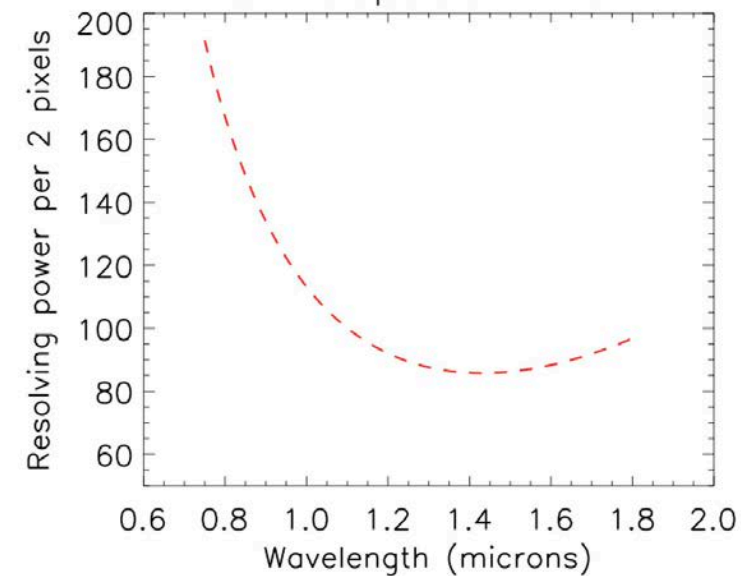
Roman Effective Area



Roman Effective Area



Low-dispersion Prism



# Roman Data Levels

Level 0	Science telemetry: Packetized data as it arrives from the spacecraft
Level 1	Uncalibrated exposures: include metadata, engineering data
Level 2	Calibrated exposures: remove detector signature, map to scene flux
Level 3	Resampled data: use rectified grid, coadd multiple exposures as appropriate
Level 4	High-level data: mostly source-oriented, include catalogs, extracted spectra, postage stamps, high fidelity flux, shape, morphology measurements
Level 5	Community-contributed products: may include any of the above types